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SUMMARY OF WEBBING AND NET FRAGMENTS FOUND ON NORTHWESTERN HAWAIIAN ISLANDS BEACHES, 1982-86

John R. Henderson, Susan L. Austin, and Miriam B. Pillos
Southwest Fisheries Center Honolulu Laboratory
National Marine Fisheries Service, NOAA
Honolulu, Hawaii 96822-2396

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INTRODUCTION

Lost or discarded fish netting, lines, and other debris wash ashore and accumulate on the beaches and inshore reefs of the Northwestern Hawaiian Islands (NWHI). This debris has been documented to entangle Hawaiian monk seals (Andre and Ittner 1980; Henderson 1984, 1985), marine turtles (Balazs 1985), and seabirds (Conant 1984). While the presence of such debris has been documented, quantifying or identifying webbing or other materials found on NWHI beaches has not been done.

Debris found on Alaska beaches has been measured and sampled (Scordino and Fisher 1983; Scordino et al. 1984; Fowler et al. 1985), and such measurements have been used in estimating the impact of entanglement on populations of the northern fur seal (Fowler 1982, 1985). Weight and mesh size of fragments which entangle seals may not be representative of those found on a beach. Whereas most documented northern fur seal entanglements occur in webbing fragments of >200 mm mesh size (Scordino 1985), fragments with mesh of such size comprise only 30% of the number of fragments found on Pribilof Island beaches (Fowler et al. 1985).

The purpose of the present study was to quantify and identify the sources of webbing which wash ashore in the NWHI, and to assess the hazard these nets present to Hawaiian monk seals. Lines and other hazardous debris are being classified and will be summarized in a future report.

METHODS

Beaches within the NWHI were regularly patrolled by personnel present on the island, and nets and other hazardous debris which washed ashore, as well as similar debris already present, were measured, cataloged, and sampled. Data collected in the field included location, type of material, and approximate size of fragment. Nets were untangled to obtain length and width measurements when it was practical to do so, otherwise length, width, and height measurements were taken of the "pile" of net. Samples of approximately 0.25 m^2 area were collected from nets for subsequent measurement and identification. If more than one type of webbing washed ashore in a single, tangled aggregate, each type of webbing was cataloged separately, though recorded as having come from a single mass. Samples were weighed and stretched mesh size and twine diameter were measured. Stretched mesh size was measured on a single mesh using a calibrated wedge of plexiglass to expand the mesh, and twine diameter was measured with calipers. Weight of samples was measured on a digital platform scale. Weight estimates of the original net fragment were derived by extrapolating from the size and weight of the sample to the original.

After all nets had been cataloged and sampled, the remaining debris on the beach was collected and burned, usually shortly before departure of personnel from the island. Nets present upon arrival at the island the subsequent year are, therefore, assumed to have drifted onto the island or to have been uncovered by wave action on the beaches during the interim period.

Nets and other debris washing ashore at Tern Island, French Frigate Shoals are routinely collected and burned by U.S. Fish and Wildlife Service (USFWS) field personnel who are present on the island all year. Data on this debris are not collected, and Tern Island is, therefore, excluded from French Frigate Shoals in this study. Nets collected in 1986 have been tallied, but samples have not been weighed or measured. Data from 1986 are, therefore, included only in analyses of accumulation rates and locations within islands.

Perimeters of islands or islets within atolls were derived from geographic data presented in Woodward 1972 (Kure Atoll), Amerson et al. 1974 (Pearl and Hermes Reef), Clapp and Wirtz 1975 (Lisianski Island), and Ely and Clapp 1973 (Laysan Island). Perimeters of islets within French Frigate Shoals were derived from data presented in Amerson (1971), with the exception of East and Whale-Skate Islands, perimeters of which were derived from measurements on NOAA nautical chart No. 19401.

RESULTS

Amount of Nets

The number of nets and net fragments found is presented in Table 1.

Table 1.--Number of net fragments recovered from Northwestern Hawaiian Islands beaches (* = incomplete data).

Location	1982	1983	1984	1985	1986	Total
Lisianski Island	71	18	30	42	52	213
Laysan Island	24	3	2*	7	31	67
French Frigate Shoals	19	ND	33	38	7	97
Pearl and Hermes Reef	36	ND	55	7	33	131
Kure Atoll	30	33	39	145	18	141
Total	180	54	159	239	141	773

The annual accumulation of nets or fragments relative to the perimeter of emergent land varied considerably by both year and location (Table 2). Because the beaches were cleared of fragments in all years, including those for which data are missing, the number of fragments recovered in the subsequent year are considered to represent 1 year's accumulation. A Kruskal-Wallis test (Conover 1971) of accumulation rates revealed no significant differences among the five locations ($T = 6.63$, $df = 4$, χ^2 approximation $P > 0.1$).

Table 2.--Annual accumulation (nets per kilometer) of nets and net fragments on Northwestern Hawaiian Islands.

Location	Beach perimeter (km)	1982-83	1983-84	1984-85	1985-86
French Frigate Shoals	6.9*	ND	4.76	5.48	1.01
Laysan Island	8.8**	0.34	ND	0.80	3.52
Lisianski Island	5.3	3.43	5.71	8.00	9.81
Pearl and Hermes Reef	6.8	ND	8.03	1.02	4.85
Kure Atoll	5.4	6.11	7.22	27.85	3.33

*Excludes Tern Island.
**Excludes southwest ledge.

Distribution of Nets at Each Island Location

The sectors in which net fragments were found on Lisianski and Laysan Islands are presented in Figures 1 and 2. On Lisianski Island, net fragments do not wash ashore uniformly about the island ($\chi^2 = 418.4$, $df = 48$, $P < 0.01$), but rather predominate in the northwest (Sectors 3-7) and east/southeast (Sectors 15-35) portions of the island. The southwest corner of Laysan Island (Sector 16) is a tall rock ledge where net fragments cannot wash ashore and has been omitted as a potential debris location. As at Lisianski, the spatial distribution of net fragments at Laysan is nonuniform about the island ($\chi^2 = 110.3$, $df = 18$, $P < 0.01$), with most fragments washing ashore in the northeast corner of the island (Sectors 5-8).

Locations of nets which washed ashore at French Frigate Shoals are depicted in Figure 3. This location differs from Lisianski and Laysan in that it is a multi-islet atoll. Because the perimeters of the various islets differ, the data are presented per kilometer of beach. Accumulation differed significantly among the remaining islets ($\chi^2 = 181.1$, $df = 7$, $P < 0.01$), with East, Whale-Skate, and Trig Islands accumulating the most nets and net fragments.

Locations of nets at Kure Atoll are shown in Figure 4. Totals are presented for sectors on Green Island, the only permanent islet in the atoll, as well as for the three smaller, nonvegetated islets and the lagoon waters. Distribution of net fragments about Green Island is nonuniform ($\chi^2 = 48.7$, $df = 7$, $P < 0.01$), with Sector 2, the north point, accumulating more fragments than any other sector.

Types of Webbing

The 632 nets or net fragments collected through 1985 were comprised of the following materials: "poly," i.e., polypropylene or polyethylene, 539

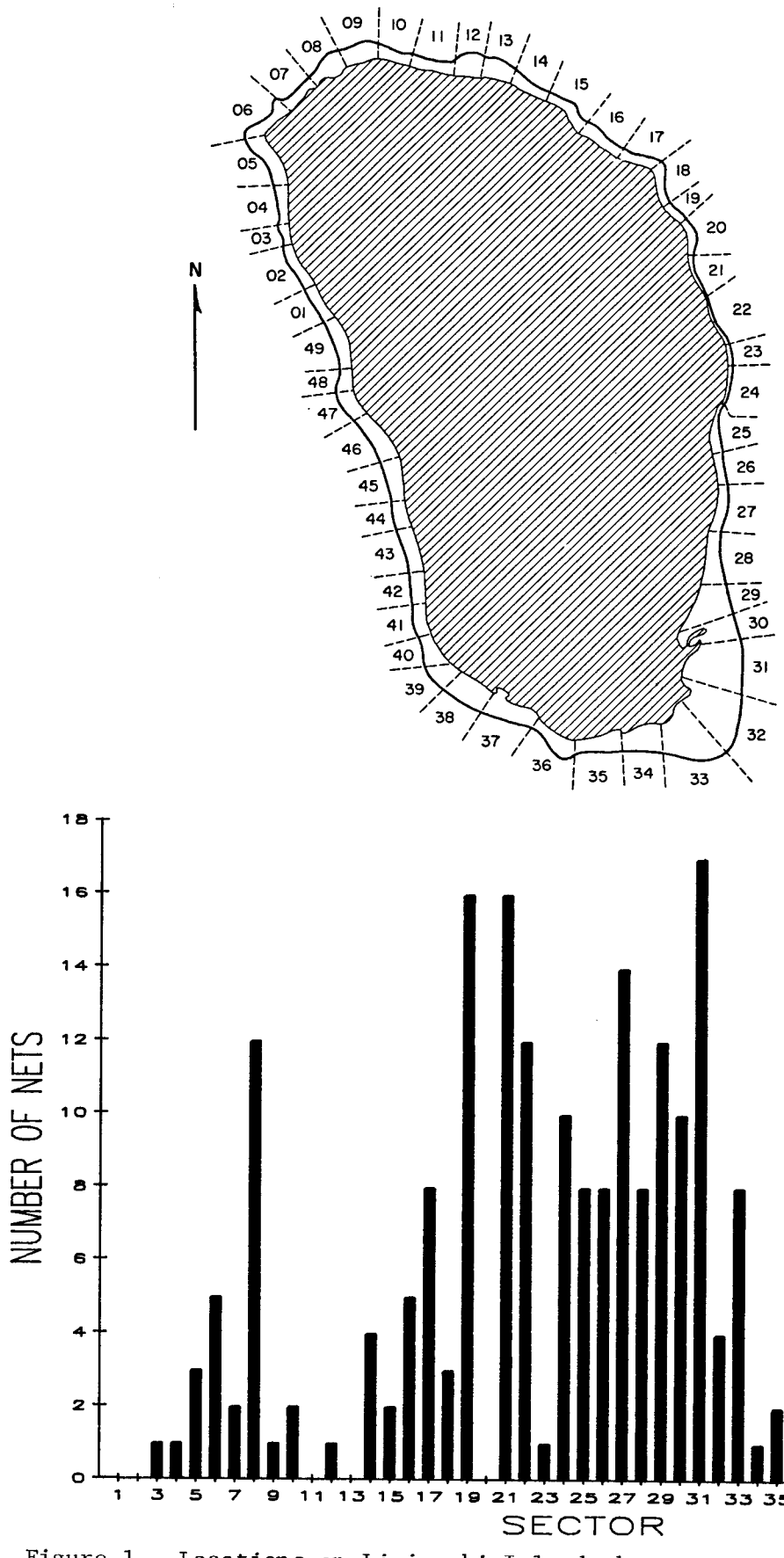
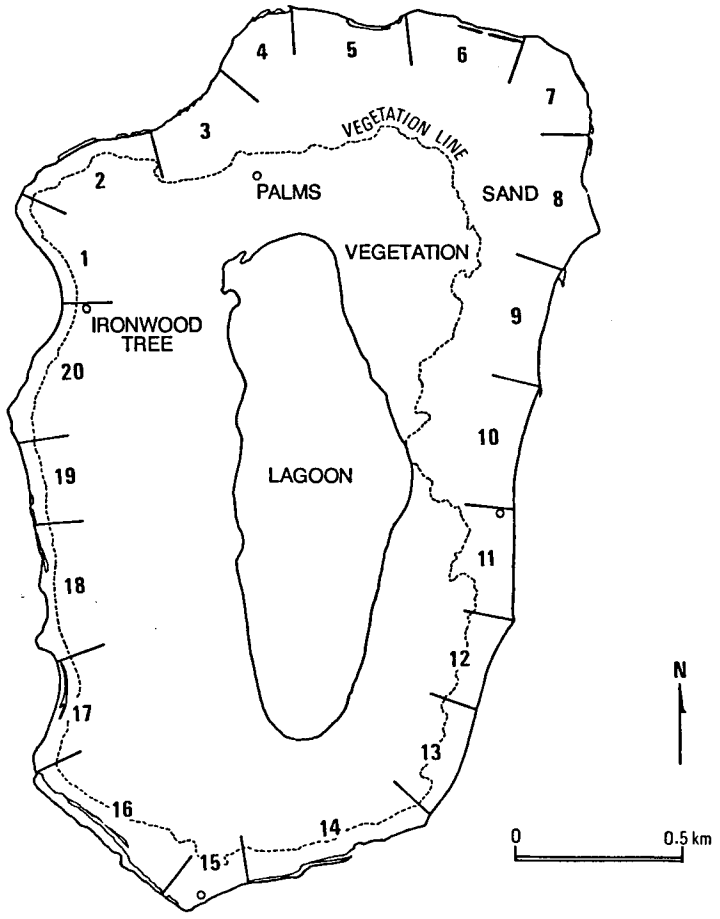


Figure 1.--Locations on Lisianski Island where nets and net fragments were found, 1982-86.



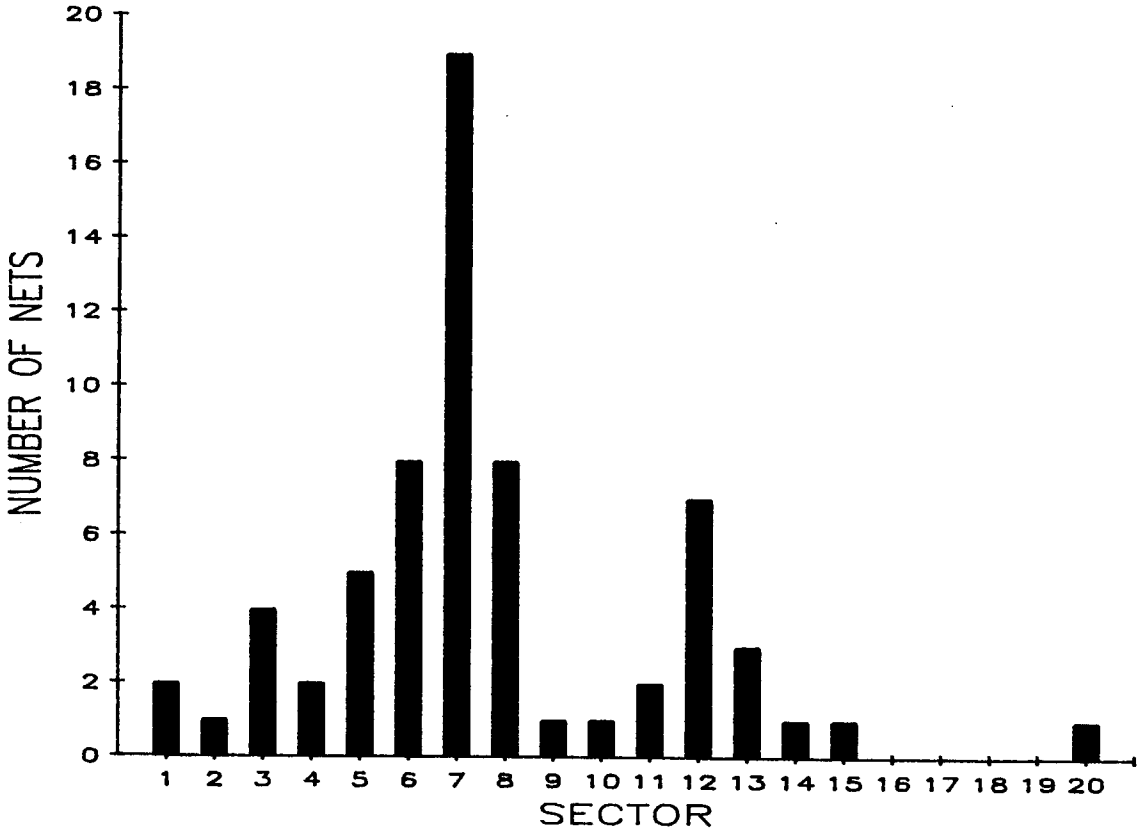
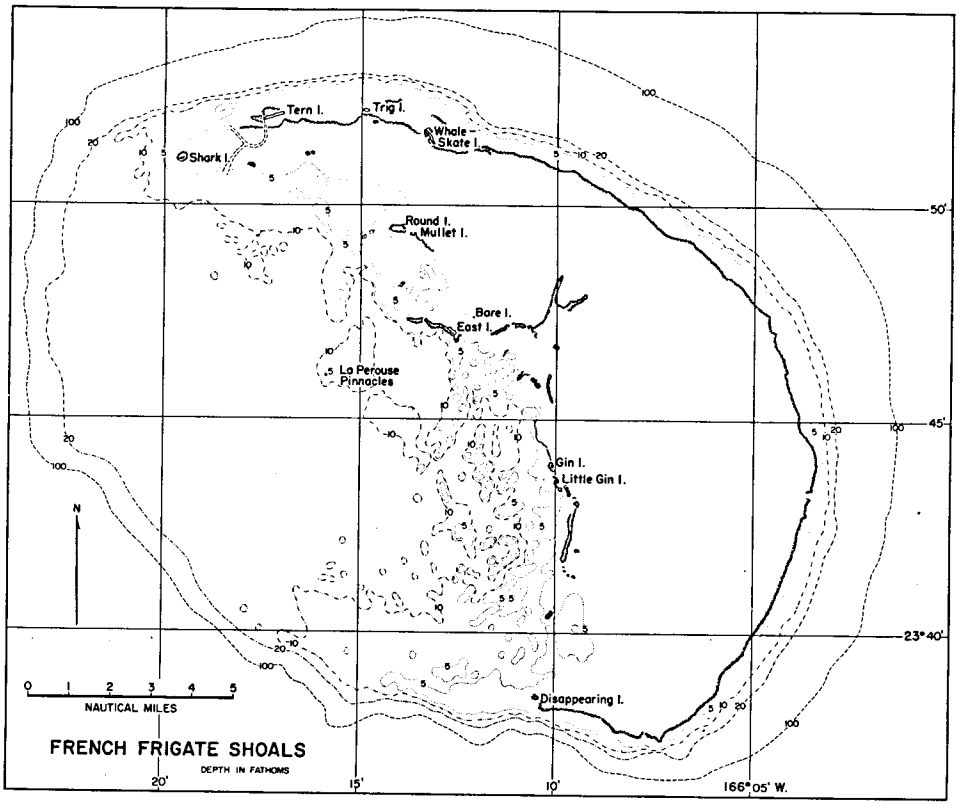


Figure 2.--Locations on Laysan Island where nets and net fragments were found, 1982-86.



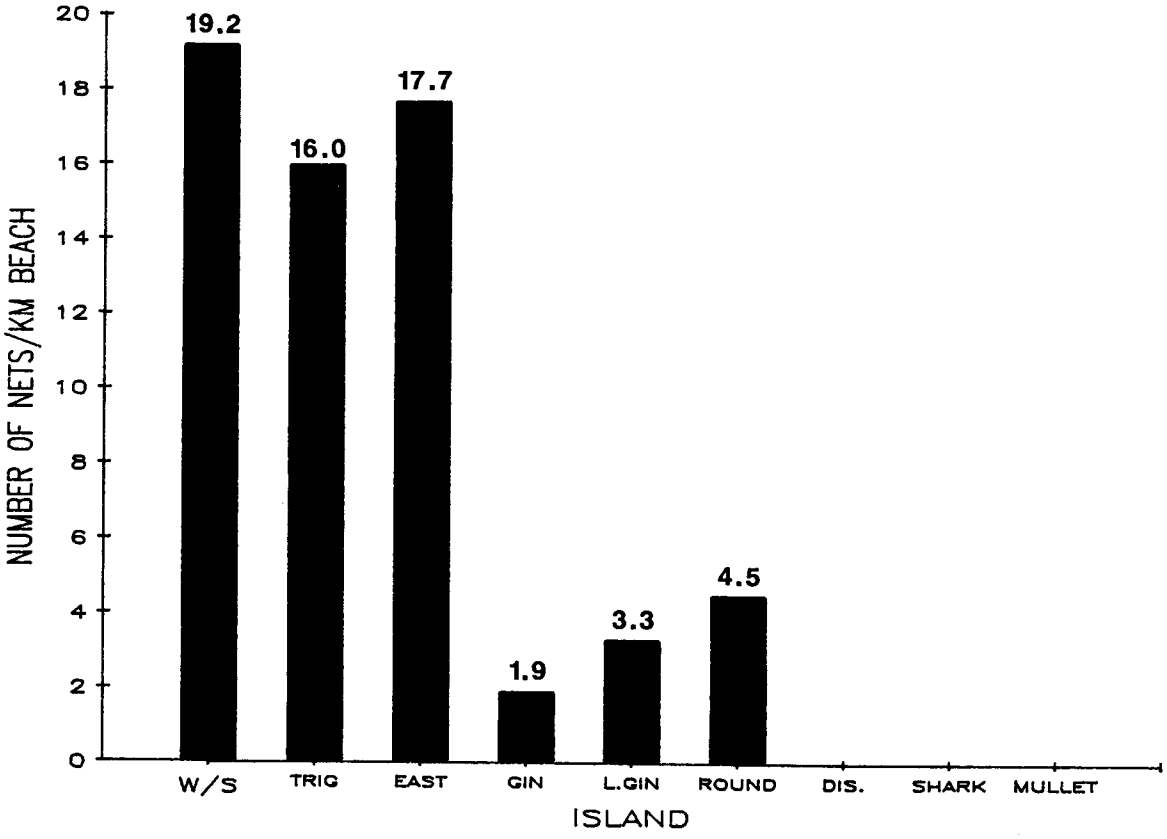
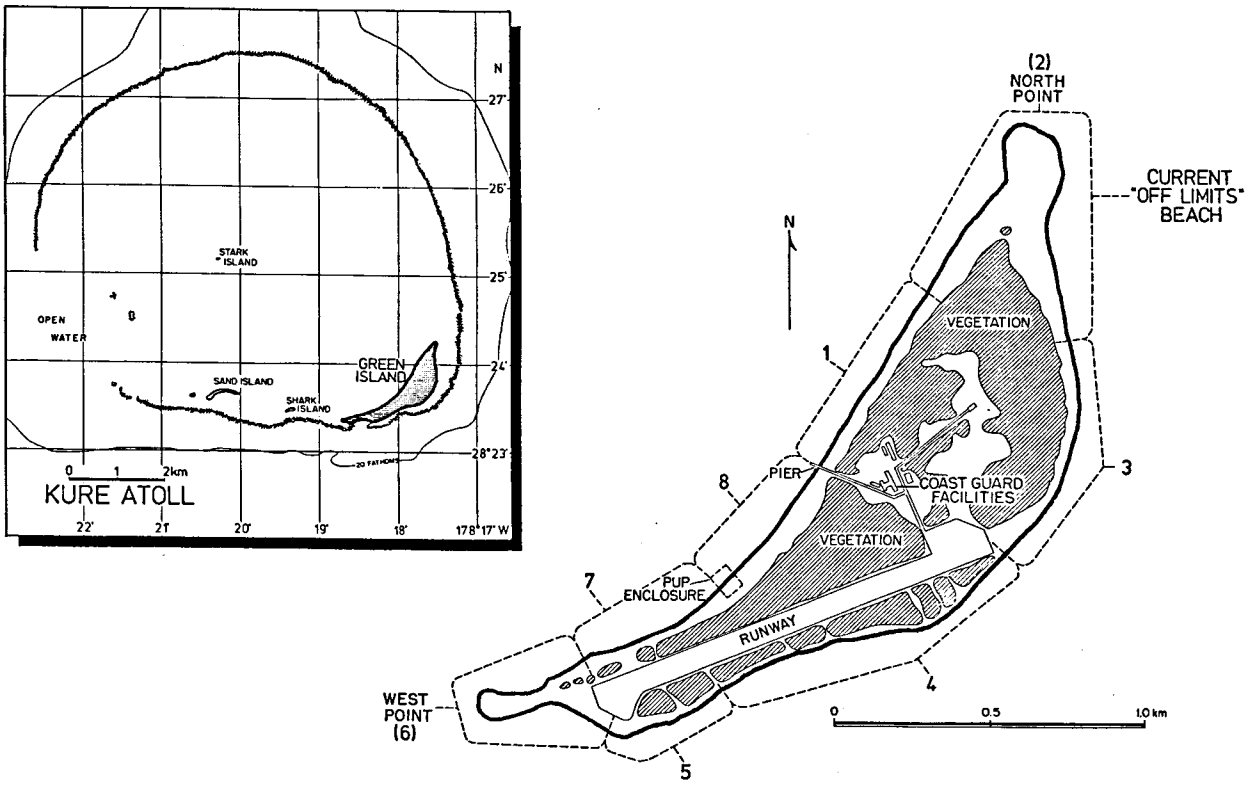


Figure 3.--Locations on French Frigate Shoals where nets and net fragments were found, 1982-86.



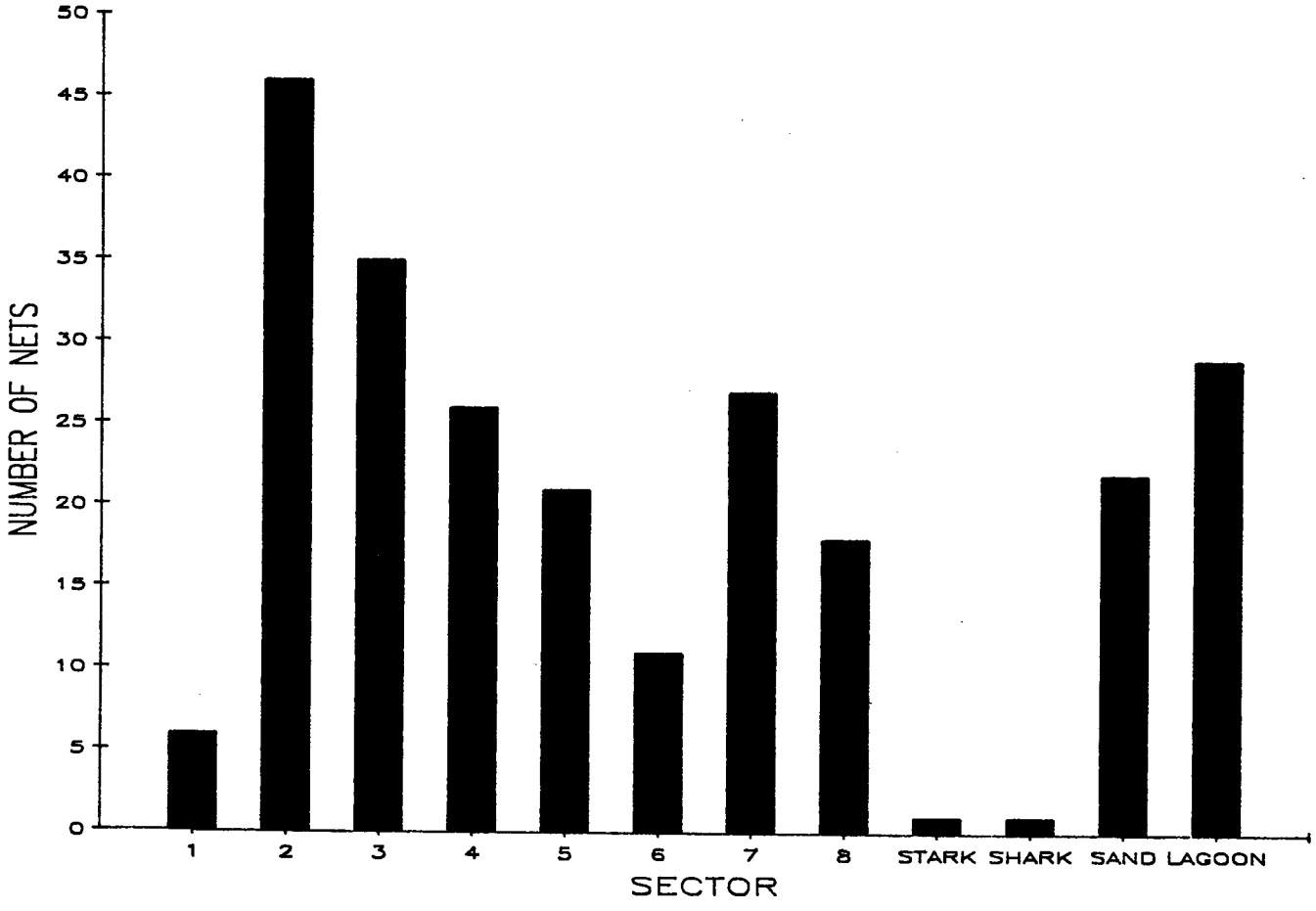


Figure 4.--Locations on Kure Atoll where nets and net fragments were found, 1982-86.

(85.3%); nylon monofilament, 66 (10.4%); and other materials (nylon multifilament or cotton), 9 (1.4%). Type of material was not noted for 18 samples (2.8%).

All monofilament webbing was considered to be from gill nets. Mesh sizes and probable source fishery for the 59 gill nets or gill-net fragments are presented in Table 3. At the time samples were collected, it was not known that lead or float lines could help determine the type of net; hence, only webbing was sampled and source fisheries have, therefore, been assigned solely on the basis of mesh size. Mesh sizes of 110-115 mm overlap between salmon and squid gill-net fisheries; hence, fragments of this mesh may be from either fishery.

Table 3.--Number of gill-net fragments found on beaches of Northwestern Hawaiian Islands 1982-85 with probable source fishery (Jones 1982; Gong 1985; Uchida 1985).

Mesh size (mm)	No.	Probable source fishery
Unknown	5	Unknown
15	1	Soviet saury/anchovy (?)
50-58	4	North American coastal herring
80-93	11	Unknown
95-109	21	High seas squid
110-115	14	High seas or Asian land-based salmon or high seas squid
119-130	8	High seas salmon
140-160	2	North American coastal salmon

A wide variety of net fisheries are potential sources of "poly" webbing, and the type of webbing used in any one net fishery is variable. A single midwater trawl may contain, for example, up to 12 different types of webbing (FAO 1965), and different nationalities may use different webbing even if engaged in the same fishery. Thus, determining the source of "poly" net fragments is difficult, particularly when the fragment has no floats, lines, nor seams which could facilitate identification. Nonetheless, because midwater and bottom trawling constitute the largest components of nongillnet fishing in the North Pacific, most of the "poly" net fragments are likely to have originated from midwater or bottom trawls.

One portion of a trawl which may be easily identifiable is the cod end. Twine used in cod ends is heavy, usually at least 6 mm in diameter (W. West, Northwest and Alaska Fisheries Center, pers. commun. 1985), and may be double meshed. Mesh size of groundfish trawl cod ends in the North Pacific range from 80 to 130 mm (Low et al. 1985). Using these criteria, 17 (3.2%) of the 539 "poly" fragments were cod ends from groundfish trawls. An additional 23 (4.3%) of fragments were characterized

by twine diameters >6 mm and mesh sizes <80 mm, and may represent fragments of trawl cod ends used in fisheries other than for groundfish.

Mesh Size

Mesh size was determined for 600 fragments of webbing, 534 of which were from "poly" nets. Distribution of mesh sizes for these fragments is presented in Figure 5 in comparison with similar data for trawl fragments found on Alaskan island beaches. Fragments of mesh size 200 mm or smaller comprised 96.8% (by number) of all "poly" webbing collected, and fragments of very small mesh (<50 mm) comprised 11.1% of the sample, a much larger percentage than was found on Alaskan beaches.

The distribution of mesh size for the sample of gill-net fragments is presented in Table 3.

Weight

Weights of trawl fragments are shown in Figure 6, and are presented in comparison with similar data for Alaskan island beaches. A much larger proportion (20.3% versus 7.6%) of fragments weighing <0.1 kg were found on NWHI beaches. The proportion of larger fragments (>2.0 kg) was similar for both locations (32.9% versus 31.0%).

DISCUSSION

No difference is apparent in the amount of webbing washing ashore at different locations within the NWHI. Data from Lisianski, Laysan, and Kure, however, indicate that at any one island, windward (northeast) facing beaches tend to accumulate more debris. The distribution at Lisianski is significant in that those areas accumulating the most webbing are also areas in which most births and weanings of monk seals occur (Johanos and Henderson 1986; Johanos and Kam 1986). Recently weaned monk seal pups have been observed entangled more often than other size-classes (Henderson 1984).

Data from French Frigate Shoals indicate that debris may accumulate faster at certain islets within one atoll. These islets (East, Whale-Skate, and Trig) are permanent, vegetated islets, whereas the islands which accumulated fewer nets (Gin, Little Gin, Disappearing, Mullet, Round, and Shark) are unvegetated and more likely to be overwashed during storms. Thus, nets which wash ashore during the winter when personnel do not regularly visit these islets may be washed away, not accumulating as on the other islets. Currents in the atoll which have led to the accretion of more permanent islets may also concentrate flotsam in the same manner.

As at Lisianski, the accumulation pattern of webbing at French Frigate Shoals presents a particular threat to weaned pups. Two of the islets accumulating the most webbing (East and Whale-Skate) are major pupping

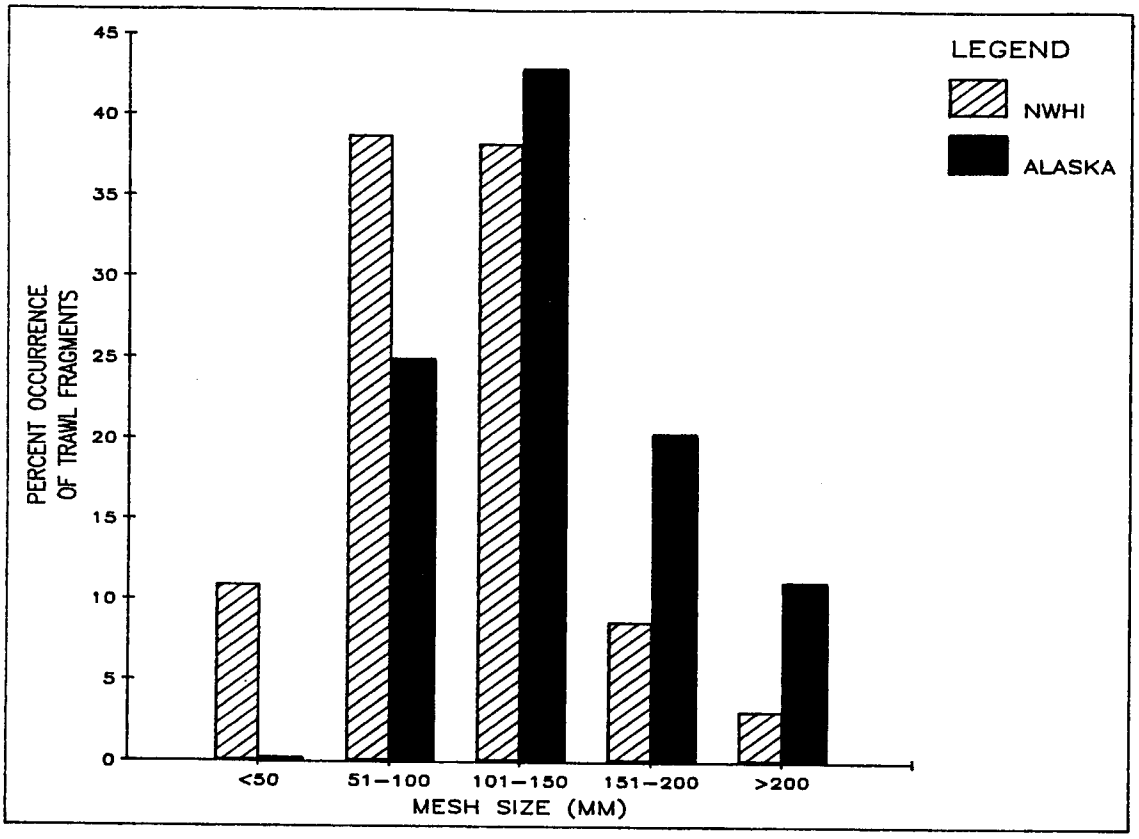


Figure 5.--Percent occurrence (by number) of mesh sizes of trawl fragments found in the Northwestern Hawaiian Islands, 1982-85. Data for Alaskan islands are from Fowler et al. 1985.

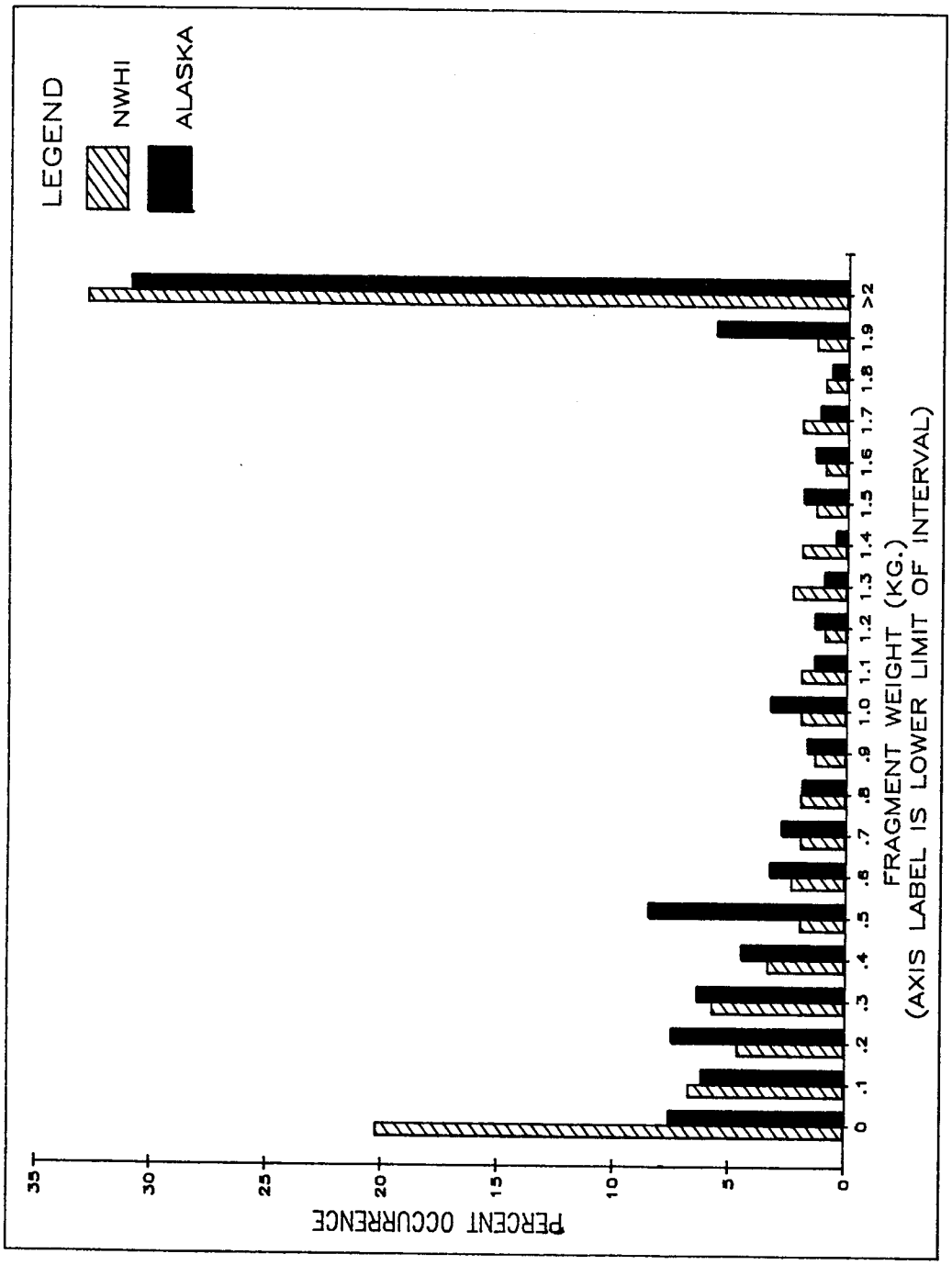


Figure 6.--Percent occurrence (by number) of weight of trawl fragments found in the Northwestern Hawaiian Islands, 1982-85. Data for Alaskan islands are from Fowler et al. 1985.

locations. In 1983, an estimated 48% of all monk seal pups born in the NWHI were born at these two islets.[1]

The relatively low number of gill-net fragments compared with trawl net fragments found on NWHI beaches is noteworthy. Gillnetting for squid occurs in closer proximity to the Hawaiian Archipelago than does trawling, and the total deployment of all gill nets (including salmon) far exceeds that of trawls (Fredin 1985; Shima 1985). Perhaps the nature of trawl fishing causes more gear loss than gillnetting, or damaged trawls may more often be repaired at sea rather than being replaced completely, leading to more discard of fragments.

Webbing of large (>200 mm) mesh size occurs with less frequency on NWHI beaches than on Alaskan island beaches. Nonetheless, this does not diminish the risk to monk seals. Whereas northern fur seals tend to become entangled in intact meshes, particularly meshes >200 mm (Scordino and Fisher 1983), Hawaiian monk seals have more often been observed in holes within webbing, rather than through meshes. Furthermore, monk seals have been observed entangled in a wide variety of mesh sizes.

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